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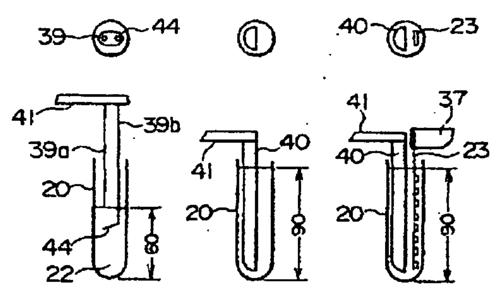
(54) Analytical method and analytical apparatus using test strips.

(57) A sample container (20) containing a urine sample (22) is transferred by a sample positioning device to a liquid level sensing position. At this sensing position, the liquid level in the sample container is detected by a level sensor (39), followed by transfer of the sample container to a dipping position. A liquid level rising member (40) is then inserted to the sample container. While being held by a handling device, a test strip (23) is dipped into the sample in the sample container with the liquid level raised. Thereafter, the test strip (23) is lifted out of the sample container (20) and transferred to a measuring device. Color development in reagent sections on the test strip is measured by a photometer in terms of the reflected light strength. With the present invention, analysis using test strips can be implemented even when the sample volume sampled into the sample container is small.

FIG. 4A FIG. 4B FIG. 4C



EP 0 538 830 A1

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to an analytical method and an analytical apparatus using test strips, and more particularly to an analytical method and an analytical apparatus in which a biological sample such as urine or blood is caused to develop color reaction in reagent sections on test strips.

DESCRIPTION OF THE PRIOR ART

A method of analyzing using test strips, each of which is made by impregnating small strips of felt or the like with reagents to form a plurality of reagent sections or test sections, and bonding the small strips to a plastic stick, has been adopted, for example, in a screening test for group examination and diagnosis of diseases. An apparatus capable of automatically carrying out operations necessary for such a method is disclosed in Japanese patent unexamined publication 61-91571. Note that this Japanese patent unexamined publication 61-91571 corresponds to U.S. Patent 4,876,204.

In the analytical apparatus of analyzing disclosed in the above-cited Japanese patent unexamined publication 61-91571, a test strip supplied from an automatic supply device one by one is held by a handling device, and the held test strip is dipped into a sample liquid in a sample container. After that, the test strip is lifted out of the sample container and transferred to a reaction table. The test strip is then transported to a light detecting portion where colored reagent sections are measured.

That prior art also discloses an arrangement for measuring a sample liquid level in the sample container and giving an advance notice of insufficiency of the sample liquid, prior to dipping the test strip into the sample liquid. Further, an arrangement for detecting the liquid level in bottles is disclosed in U.S. Patent 4,451,433. In this U.S. Patent 4,451,433, the liquid level of reagent solutions supplied to a chemical analyzer is detected by a pair of electrodes.

In the apparatus of the above-cited Japanese patent unexamined publication 61-91571, those samples of which volumes are not enough to make the reagent sections of the test strip thoroughly dipped in the sample liquid are all disabled from measuring and, therefore, automatic measurement cannot be achieved. More specifically, the test strip comprises a plastic stick having a plurality of reagent sections arranged in the direction of stick length. To make all the reagent sections thoroughly dipped in a sample, it is required that a sufficient volume of sample has been sampled in the sample container. In the practical working field, however, samples are occasionally sampled such that the sample volumes are too small to provide a sufficient liquid depth in the sample containers.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an analytical method and an analytical apparatus by which multi-item analysis can be performed using test strips even when the volume of a sample liquid contained in a sample container is not sufficient.

According to the present invention, there is provided for an analytical method using test strips each of which has reagent sections able to develop colors upon contact with a sample, the test strip being dipped into a sample liquid in a sample container, the reagent sections being then subjected to optical measurement, wherein the sample container is reduced in sectional area of its effective volume to contain the sample liquid, thereby raising a surface level of the sample liquid, and the test strip is dipped into the sample liquid while the sample liquid level is kept raised.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic view showing the overall construction of a urine analyzer to which the present invention is applied.

Figs. 2A and 2B show an example of a test strip; Fig. 2A is a top plan view and Fig. 2B is a side elevational view.

Figs. 3A and 3B show a structural example of a cassette in which test strips are stored; Fig. 3A is a vertical sectional view and Fig. 3B is a front view.

Figs. 4A, 4B and 4C show a principal part of the analyzer shown in Fig. 1 and are illustrations for explaining successive operation steps of a sample liquid level adjustable device.

Fig. 5 is a flowchart showing operations of the analyzer shown in Fig. 1.

Fig. 6 is a schematic view for explaining a principal part of another embodiment of the present invention.

Fig. 7 is a schematic view for explaining a principal part of a further embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A sample container is supplied in a state that a sample liquid is contained. A test strip has a plurality of reagent sections arranged in series thereon corresponding to multiple analytical items. The vol-

ume of the sample liquid necessary for making all the reagent sections thoroughly dipped into the sample liquid is related to the depth and sectional area of the sample container, as well as the depth by which the test strip is inserted to the sample container.

For convenience of description, the surface level of the sample liquid at which all the reagent sections can thoroughly be dipped into the sample liquid will be referred to as a reference level. The reference level is related to the bottom of sample containing chamber of the sample container and a level position adapted to completely cover the uppermost reagent section when the inserted test strip is maximally lowered. In general, the distance between the bottom of sample containing chamber of the sample container and the lower end of the test strip suspended from handling means during the dipping is always kept constant. When the sample liquid level in the sample container prior to dipping of the test strip does not reach the reference level, it is difficult to make all the reagent sections contacted with the sample liquid. To cope with this difficultly, therefore, the test strip is dipped after raising the sample liquid level in the sample container.

In order to raise the sample liquid level, a liquid level rising member for reducing the sectional area of effective volume of the sample container itself to contain the sample liquid is inserted to the sample container. This liquid level rising member preferably comprises a rod-like member having the outer configuration a part of which is formed in conformity with the shape of an inner wall of the sample container. The liquid level rising member, supported in a vertically movable manner, is designed in the configuration and the inserted position thereof so that the insertion of the test strip into the sample container will not be prevented. When the liquid level rising member is lowered to enter the sample liquid, the sample liquid level in the sample container is raised depending on the cubic volume of the liquid level rising member that has entered the sample liquid. Under a state that the sample liquid level is equal to or higher than the reference level, the test strip is dipped into the sample liquid. All the reagent sections can thereby be contacted with the sample liquid for the same period of time, making it possible to uniformly keep start conditions for color developing reactions in the reagent sections.

A urine analyzer shown in Fig. 1 comprises a sample positioning device 14, a test strip automatic supply device 15, a test strip handing device 16, a liquid level adjustable device 18, a measuring device 17, and a control and data processing device 19. The sample positioning device 14 includes a plurality of sample containers, each containing a sample liquid, arranged thereon and operates to successively transfer and position the sample containers to a test strip dipping position. The test strip automatic supply device 15 accommodates a plurality of test strips and operates to deliver the test strips one by one to a pick-up position. The test strip handing device 16 grasps the delivered test strip, dips it into the sample liquid in the sample container held at the dipping position, and thereafter transfer the same to a test strip setting position in the measuring device 17. In the measuring device 17, the set test strip is transferred to a measuring position to conduct a measurement. When dipping the test strip by the test strip handing device 16 into the sample liquid, if the sample liquid level in the sample container is lower than the reference level at which the portion of the test strip that contributes to reactions for analysis of the test strip can thoroughly be dipped into the sample liquid, the liquid level adjustable device 18 inserts a liquid level rising member or rod 40 into the sample container to such an extent that the sample liquid level is raised up to the predetermined or reference level.

In a preferred embodiment of the present invention, the liquid level adjustable device 18 includes a liquid level sensor. The liquid level sensor may be of the type that electrodes are inserted to the sample container to detect contact of the electrodes with the liquid surface, or the type that the liquid level is optically detected from the outside of the sample container. Control of the extent by which the liquid level rising member is inserted to the sample container, and operation of dipping the test strip into the sample container by the test strip handing device 16 are performed by one of the following first and second methods, or a combination of the twos.

With the first method, the sample liquid level is measured before the liquid level rising member is inserted to the sample container. More specifically, prior to insertion of the liquid level rising member into the sample container, the liquid level sensor of electrode type is inserted to the sample container for measuring the sample volume or the sample liquid level in the sample container. Based on the measurement result, the control and data processing device 19 calculates and determined the extent of insertion of the liquid level rising member which is necessary for raising the sample liquid level in the sample container up to the predetermined level. Then, the sample liquid level adjustable device is operated to insert the liquid level rising member into the sample container so that the sample liquid level in the sample container is raised up to the predetermined level enough to make the test strip thoroughly dipped into the sample container. After that, the test strip handling device is operated to

dip the test strip into the sample liquid in the sample container.

With the second method, the sample liquid level in the sample container is detected while inserting the liquid level rising member into the sample container. In this case, the liquid level sensor is set beforehand at a desired level position. When the liquid level is raised to reach the sensor position, that liquid level is detected, whereupon the operation of inserting the liquid level rising member is stopped. Specifically, after setting of the sensor, the liquid level adjustable device is operated to insert the liquid level rising member into the sample container, thereby raising the sample liquid level in the sample container up to the position detectable by the sensor. In this state, the sample liquid level reaches the predetermined level necessary for making the test strip dipped in the sample liquid. Thereafter, the test strip is dipped into the sample liquid in the sample container.

As the liquid level rising member, there is used a rod-like member formed such that the portion which is inserted to the sample container has a length at least 1/2 or more of, preferably almost equal to, the length of the sample container, and the main portion which is dipped into the sample liquid has a sectional area at least 1/5 or more, preferably 1/3 or more, in terms of the inner diameter of the sample container. The liquid level rising member is configured and located in relation to the sample container so that the insertion of the test strip into the sample container will not be prevented.

Fig. 1 shows a structural view of an automatic urine analyzer to which the present invention is applied. In the sample positioning device 14, a plurality of sample containers 20 each containing a urine sample to be analyzed are arranged on a turntable 21. The turntable 21 is turned with predetermined time intervals for successively transferring the sample containers 20 to a test strip dipping position B. The number of the sample containers allowed to be loaded on the turntable 21 is 60 in the illustrated embodiment. The test strip automatic supply device 15 has a function to supply test strips 23, which are stored beforehand in place, one by one to a pick-up position A in synchronism with the analytical cycle.

As shown in Fig. 2, the test strip 23 comprises a rectangular stick plate or stick 24 on which a plurality of reagent sections (or test sections) are arranged in the direction of stick length. The reagent sections respectively correspond to individual analytical items. The test strip 23 has a grip region 2 at one end side. Each reagent section 25 is formed of a small strip of filter paper or felt impregnated with a reagent corresponding to the analytical item. In the example shown in Fig. 2, the test strip includes eleven small strips in total; namely ten reagent sections subjected to analysis and one standard section for color compensation. The test strip has an overall length of about 120 mm and the length of region of the reagent sections is about 90 mm. To make the whole of the reagent sections thoroughly dipped into the sample liquid, therefore, the sample liquid in the sample container is required to have a liquid level not lower than 90 mm. The sample container usually employed in urine analysis is approximately 100 mm long.

Figs. 3A and 3B show the structure of a test strip cassette 26 storing the test strips 23 therein. The test strips 23 are stored in the cassette 26 such that they are pressed toward a take-out port 29 by a leaf spring 28 via a retainer plate 27. The cassette 26 is mounted to a cassette holder 30 of the test strip automatic supply device 15, and a test strip delivery device 32 operated by a motor 31 delivers the test strips one by one to the pick-up position A. The test strip automatic supply device 15 includes two units of cassettes 26 each capable of storing 100 pieces of the test strips 23. When one cassette 26a is exhausted up, a cassette change-over device 34 is turned to automatically replace it by the other new cassette 26b.

The test strip handling device 16 shown in Fig. 1 includes a drive mechanism 36 for causing an arm 35 to move vertically and swing or rotate about a vertical shaft, and a test strip gripper (or a grip) 37 attached to the distal end of the arm 35 in such a manner as able to detachably hold the test strip 23 and rotate about its axis. The test strip handling device 16 grasps the test strip 23 in the pick-up position A, dips it into the sample liquid in the sample container 20 positioned in the dipping position B, lifts it out of the sample liquid after a predetermined period of time, and further transfers it to a test strip setting position C in the measuring device 17, followed by releasing the test strip from the grasped state.

In the liquid level adjustable device 18 shown in Fig. 1, a pair of liquid level sensing electrodes 39a, 39b and the liquid level rising member 40 are supported by the arm 41 to be suspended therefrom (see Fig. 4). The arm 41 is operated by a drive mechanism 42 so that it moves horizontally in directions of arrows in Fig. 1 and vertically.

Operation of adjusting the sample liquid level will now be described with reference to Figs. 1 and 4. In the turntable 21, there are provided holes 71 in the same number as holes into which the sample containers 20 are to be loaded. When the arm 41 is advanced toward the turntable 21 in the direction of one arrow in Fig. 1 and the liquid level sensing electrodes 39 are positioned at a detection position D, the liquid level rising rod (or member) 40 is

located just above the hole at a position 71a. Upon lowering the arm 41, the electrodes 39 are lowered to enter the sample container in the detection position D, while the rod 40 is lowered to penetrate through the hole at the position 71a. When the arm 41 is retracted in the opposite direction, the rod 40 and the electrodes 39 are positioned in a state as shown in Fig. 1. When the arm 41 is further retracted outwardly, the rod 40 and the electrodes 39 are positioned above a washing tank 45.

More specifically, while the liquid level adjustable device 18 is in a standby state, the rod 40 and the electrodes 39 are kept stopped above the washing tank 45. When the liquid level adjustable device 18 starts its operation, the arm 41 is advanced inwardly so that the electrodes 39 are positioned at the detection position D preceding one step from the dipping position B. Then, as the arm 41 is lowered, the electrodes 39a and 39b are caused to enter the sample container in the detection position D and are stopped at such a level position that both the electrodes are contacted with the sample liquid surface, including a case where one electrode is contacted with the sample liquid surface and the other electrode is dipped in the sample liquid (Fig. 4a). The control and data processing device 19 determines whether the detected sample liquid level or sample volume is not less than the necessary minimum level or amount. The necessary minimum level of the sample liquid surface is set beforehand as a fixed value depending on the adjustable capability of the liquid level rising rod 40, and the set value is stored in a memory of a control unit 51.

It is set in the illustrated embodiment that the sample container has a length of 100 mm, the sample liquid level necessary for making the test strip thoroughly dipped into the sample liquid is 90 mm, and further the minimum sample liquid level required to enable adjustment by the liquid level rising rod 40 up to the above necessary level is 60 mm. In a case where the sample liquid level does not reach 60 mm, this is regarded as insufficiency of the sample volume and analysis of that sample container is skipped while issuing an alarm. In a case where the sample liquid level exceeds 60 mm, the detected signal is delivered to the control unit 51 where the control and data processing deice 19 calculates, based on the liquid volume necessary for raising the sample liquid level up to 90 mm, the number of pulses applied to a pulse motor by which the liquid level rising rod 40 is inserted to the sample container, the calculated number of pulses being stored in a built-in storage.

The grounding terminal 39b of the liquid level sensing electrodes has its distal end which is bent into a scoop shape and also serves as a stirrer 44. For the sample to be analyzed, the stirrer 44 is now moved up and down several times by operating the arm 41 vertically so that the sample liquid is stirred for mixing.

After that, the sample container 20 is advanced by one step for transfer to the dipping position B, and the arm 41 is horizontally retracted by the drive mechanism 42 so that the liquid level rising rod 40 is moved to a location just above the sample container 20 in the dipping position. The liquid level rising rod 40 is then inserted to the sample container 20 depending on the number of pulses stored in the above step, followed by coming to a standstill there. This insertion of the liquid level rising rod 40 causes the sample liquid level to rise up to the level of 90 mm necessary for thorough dipping of the test strip (Fig. 4b).

While keeping the liquid level rising rod 40 inserted in the sample container, the test strip handling device 16 is operated to carry the test strip 23 and lower the same into the sample container in the dipping position for dipping into the sample liquid with one end of the test strip grasped by the grip 37 of the arm 35 (Fig. 4c). After the dipping for a predetermined period of time, the grip 37 is elevated to lift the test strip 23 out of the sample liquid for transferring it to the test strip setting position C above the measuring device 17. At the time of reaching the setting position C, the handling device 16 releases a test strip 23a, on which color developing reactions have started, from the grip 37 to be ready for a next new test strip. Thereafter, the liquid level rising rod 40 is lifted out of the sample container 20 and the arm 41 is horizontally moved toward the washing tank 45. The electrodes 39a, 39b and the liquid level rising rod 40 are lowered into the washing tank 45 and washed with a cleaning liquid, following by elevation to a standby position for analysis of the next sample.

In the measuring device 17 shown in Fig. 1, rolled paper 46 is used to transport the test strip 23a under the color developing reactions which has been received from the test strip handling device 16. The rolled paper 46 is let out and wound up by a reeling device 47 with predetermined time intervals, whereby the test strip 23a placed in the setting position C is transported toward a light detecting position E. With such an arrangement, the test strip 23a is positioned at the light detecting position E in a photometer 49 after a certain period of time from the dipping into the sample.

In the photometer 49, a plurality of small-sized optical sensors of reflection type, each of which comprises light sources formed of LEDs emitting rays of light in specific wavelengths corresponding to analytical items, respectively, and light receiving elements formed of silicon photodiodes, are arranged in one-to-one relation to positions for de-

tecting the reagent sections of the test strip 23a so that the intensity of the reflected light from each reagent section colored by the ongoing reaction is measured. The measurement results are supplied to the control unit 51 via an A/D converter 50 for data processing to be indicated on a liquid crystal display and printed by a printer 53. The analyzing operation in the present apparatus is progressed in response to an input entered from a control panel 54. The test strip on which the measurement has been completed is wound up by the reeling device 47 together with the rolled paper. After the completion of certain cycles of the measurement, the rolled paper wound up together with the test strips is removed out of the reeling device and discarded.

Fig. 5 shows a flowchart of a program example for steps of analyzing operation performed in the analyzer of Fig. 1. The analyzing operation is started in a state that the first one of the sample containers 20 loaded in the sample positioning device 14 is positioned at the liquid level sensing position D. The program for the analyzing operation is progressed with each cycle of 12 seconds by repeated operations of "washing the electrodes", "dipping the test strip" and "setting the test strip in the light detecting position", during which the test strips are successively dipped into samples on the turntable of the sample positioning device 14 and transferred to the measuring device 17. The test strips 23a transferred to the measuring device 17 are transported with a cycle of 12 seconds such that each test strip is positioned at the light detecting position E after 60 seconds from the dipping into the sample and measured by the photometer 49 which outputs the measurement result. In other words, with this program, the result of analysis on the reaction developing for 60 seconds after the dipping into the sample is obtained at a processing rate of 12 seconds for each sample.

According to the above-explained embodiment, when the sample liquid level in the sample container is in short of the level necessary for making the test strip thoroughly dipped in the sample, the sample liquid level can be raised up to such a level as allowing the thorough dipping of the test strip. Therefore, even in the foregoing case of using a test strip which has a long test region corresponding to many analytical items, it is possible to conduct analysis with a relatively small volume of the sample liquid to be prepared in the sample container, which is easy to handle.

With the increased number of items to be checked in clinical examinations, in a screening test of urine which uses test strips capable of color developing reactions, there has been employed such a test strip for multi-item analysis as including 10 or more test items. When loading those test strips on an automatic analyzer, it is troublesome and poses nerve strain for an operator to prepare numerous sample containers beforehand so that each container contains a sample liquid with its surface level enabling all reagent sections on the test strip to be thoroughly dipped in the sample liquid. However, the embodiment shown in Fig. 1 allows the operator to sample a volume of the sample liquid, which is relatively small and thus easy to handle, in each sample container. Additionally, even if the volume of the sample liquid is sampled in a rough manner, the sample liquid level can always be adjusted in the course of measurement to a height enough to make all the reagent sections on the test strip thoroughly dipped in the sample liquid.

A second embodiment according to the present invention will next be described with reference to Fig. 6. Fig. 6 shows an arrangement only in the vicinity of the test strip dipping position B. The remaining arrangement is the same as that in the analyzer of Fig. 1. This second embodiment includes a liquid level sensor for making a detection at a predetermined position that must be reached for thorough dipping of the test strip. According to a method of the second embodiment, the sensor detects that the sample liquid level raised by inserting the liquid level rising rod 40 into the sample container 20 has reached the predetermined position, whereupon the insertion of the liquid level rising rod 40 is stopped. The detecting operation is performed in the same step as when the liquid level rising rod 40 is inserted. More specifically, the sensor comprises a pair of electrode 55 and 40 (i.e., the liquid level rising rod). The electrode 55 is arranged such that it can be rotated to enter the sample container 20 by a drive mechanism 56 for operating to rotate the electrode 55 independently of the liquid level rising rod 40, and is positioned to a level position h corresponding to the sample liquid level necessary for dipping of the test strip.

The liquid level rising rod 40 is formed of conductive material and serves also as a negative electrode. With the electrode 55 thus positioned, the liquid level rising rod 40 is inserted to the sample container to raise the sample liquid level until the electrode pair detects that the sample liquid level has reached the level position h of the positive electrode 55. The insertion of the liquid level rising rod 40 is stopped in response to a detection signal, thereby providing the predetermined sample liquid level. In comparison with the method of Fig. 4, the method of this embodiment has a feature capable of directly detecting the fact that the sample liquid level has reached the predetermined level position. To realize this feature, however, it is required to provide the electrode drive mechanism 56 operating independently of the liquid level rising rod, and also take a care in the

inserted position of the positive electrode and the arrangement of the electrode drive mechanism so that the dipping of the test strip will not be interfered with.

A third embodiment according to the present invention will next be described with reference to Fig. 7. The embodiment of Fig. 7 employs optical means as a liquid level sensor. In Fig. 7, there are shown a schematic top plan view in the upper side and a schematic side view in the lower side. A small-sized optical sensor which comprises a light source formed of an LED and a light receiving element formed of a silicon photodiode, is provided at a level position h corresponding to the predetermined sample liquid level in the dipping position, thereby detecting arrival of the sample liquid level to the predetermined level for control of the extent by which the liquid level rising rod 40 is inserted to the sample container 20. If a ray of light is emitted to pass the center of the sample container 20, the liquid level rising rod 40 would interfere with the light path. For this reason, the arrangement is made to pass the ray of light offset from the center of the sample container as shown. The presence of the sample causes the light path to bend due to refraction upon entering and exiting out of the sample, so that the magnitude of a signal from the sensor is reduced. By utilizing such a signal change, rising of the sample up to the predetermined level is detected.

It should be noted that the present invention is not limited to those embodiments as mentioned above. By way of example, the sample positioning device may be arranged to move a rack, instead of the turntable 21, for transporting samples. Also, the test strip handling device 16 may be arranged to drive the arm by moving it linearly rather than rotatively or swingably. Other various mechanical transporting means than using the rolled paper may also be adopted to transport the test strips in the measuring device 17. In place of the photometer in which a plurality of sensors are provided corresponding to the individual analytical items as illustrated in the embodiment, it is further possible to carry out optical measurement while scanning the reagent sections on the test strip, by using a photometer which has a function of light detection with a plurality of wavelengths.

Claims

1. An analytical apparatus using test strips in which a test strip held by a handling device is dipped into a sample in a sample container, said test strip lifted out of said sample container is transferred from said handling device to a measuring device, and colored sections on said test strip is measured by said measuring device, wherein:

   said analytical apparatus includes a liquid level adjustable device having a liquid level rising member which can be inserted to said sample container, and said handling device dips said test strip into the sample in said sample container while said liquid level rising member is kept inserted in said sample container.

2. An analytical apparatus using test strips according to claim 1, wherein said liquid level adjustable device operates, by using said liquid level rising member, to change a depth of the sample in said sample container so that all reagent sections on said test strip are dipped into the sample.

3. An analytical apparatus using test strips according to claim 1, further comprising liquid level sensing means adapted to determine the extent by which said liquid level rising member should be inserted to said sample container.

4. An analytical apparatus using test strips which comprises a sample positioning device for positioning sample containers, each containing a sample liquid, to a predetermined position, and a test strip handling device for dipping a test strip with reagent sections formed thereon into the sample liquid in said sample container at said predetermined position and then transferring the test strip to a measuring device, wherein said analytical apparatus includes a liquid level adjustable device for inserting a liquid level rising member into said sample container at said predetermined position for raising a sample liquid level in said sample container.

5. An analytical apparatus using test strips according to claim 4, further comprising liquid level sensing means adapted to detect the sample liquid level in said sample container, wherein the depth by which said liquid level rising member should be inserted to said sample container is controlled based on a signal from said liquid level sensing means.

6. An analytical apparatus using test strips according to claim 4, wherein said liquid level rising member comprises a vertically movable rod-like member and said liquid level rising member has the outer configuration a part of which is formed in conformity with the shape of an inner wall of said sample container.

7. An analytical apparatus using test strips, comprising a liquid level adjustable device provided with a liquid level rising member which reduces the sectional area of effective volume of said sample container to contain a sample liquid, when inserted to said sample container, for raising a surface level of the sample liquid, and a test strip handling device for dipping a test strip with reagent sections formed thereon into the sample liquid in said sample container while said liquid level rising member is kept inserted in said sample container by said liquid level adjustable device.

8. An analytical method using test strips each of which has reagent sections able to develop colors upon contact with a sample, said test strip being dipped into a sample liquid in a sample container, said reagent sections being then subjected to optical measurement, wherein said sample container is reduced in the sectional area of its effective volume to contain the sample liquid, thereby raising a surface level of the sample liquid, and said test strip is dipped into the sample liquid while the sample liquid level is kept raised.

9. An analytical method using test strips according to claim 8, wherein a liquid level rising member is inserted to said sample container for reducing the sectional area of effective volume of said sample container to contain the sample liquid.

10. An analytical method using test strips according to claim 9, wherein prior to insertion of said liquid level rising member into said sample container, the sample liquid level in said sample container is detected and the depth by which said liquid level rising member should be inserted is controlled depending on the detected sample liquid level.

11. An analytical method using test strips according to claim 9, wherein said liquid level rising member is gradually inserted to said sample container, and when the sample liquid level reaches a predetermined level, the insertion movement of said liquid level rising member is stopped.

12. A sample liquid handling method wherein under a condition that a liquid level rising member for reducing the sectional area of effective volume of a sample container to contain a sample liquid is inserted in said sample container, a test strip with a plurality of reagent sections formed in the direction of strip length is dipped into the sample liquid, and after taking said test strip out of said sample container, said liquid level rising member is removed from said sample container.

13. An analytical method using test strips wherein prior to dipping a test strip into a sample container, whether a surface level of a sample liquid in said sample container has reached a reference level or not is determined based on a signal from a liquid level sensor, and when the sample liquid level has not reached said reference level, a liquid level rising member is inserted to said sample container for raising the sample liquid level until the sample liquid level reaches said reference level.

14. An analytical method using test strips according to claim 13, wherein said sample container is transferred to be successively positioned to a liquid level sensing position and a test strip dipping position such that liquid level sensing electrodes are inserted to said sample container in said liquid level sensing position and said liquid level rising member and said test strip are both inserted to said sample container in said test strip dipping position.

15. An analytical method using test strips according to claim 13, wherein when the volume of the sample liquid in said sample container is so small that the sample liquid level cannot reach said reference level even after said liquid level rising member is fully inserted down to the allowable maximum depth, an alarm is issued to give a notice of insufficient volume of the sample liquid.

FIG. 1

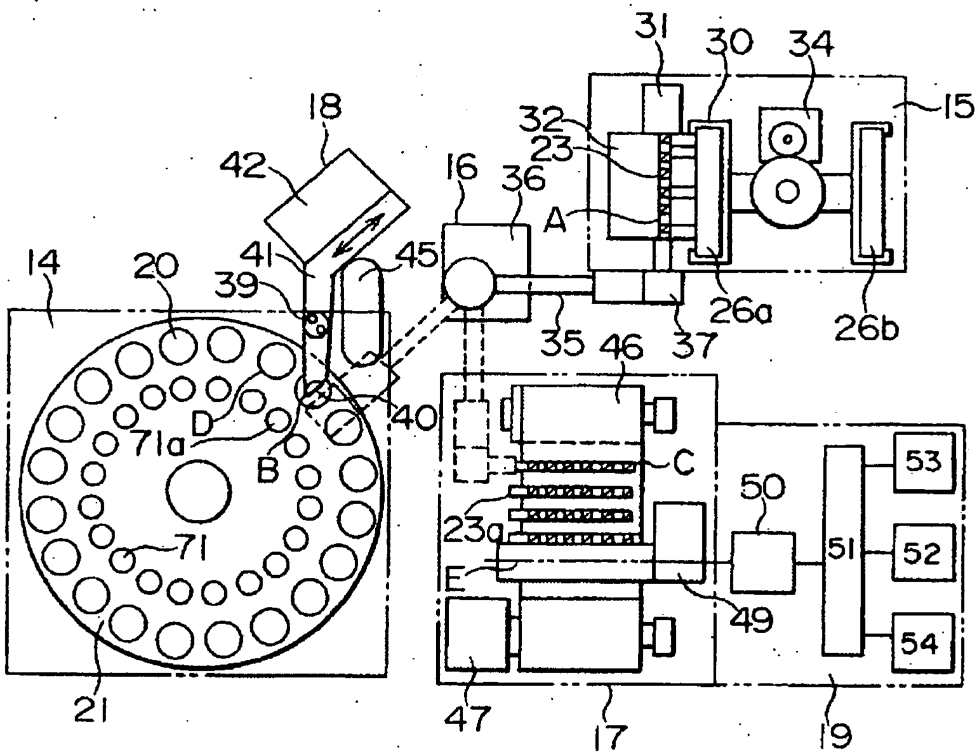


FIG. 2A

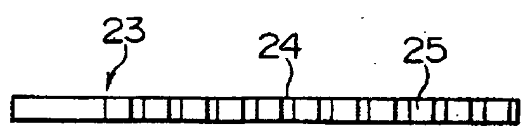


FIG. 2B

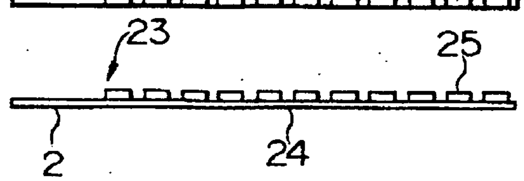


FIG. 3A

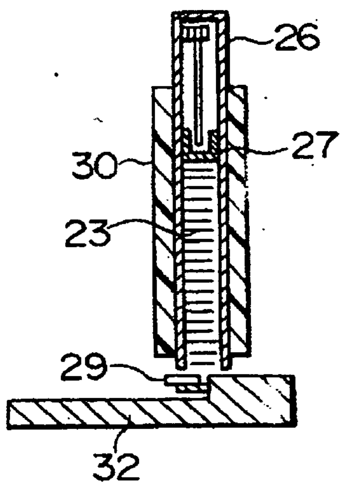


FIG. 3B

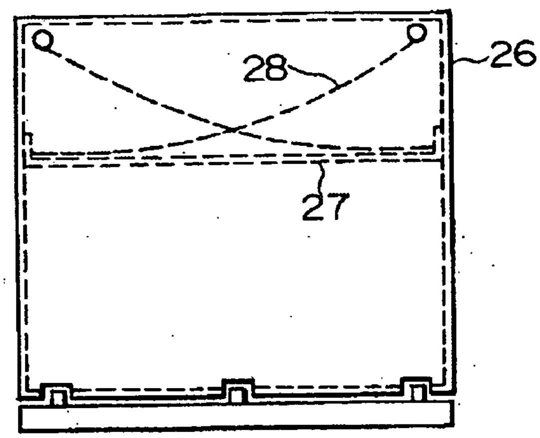


FIG. 4A

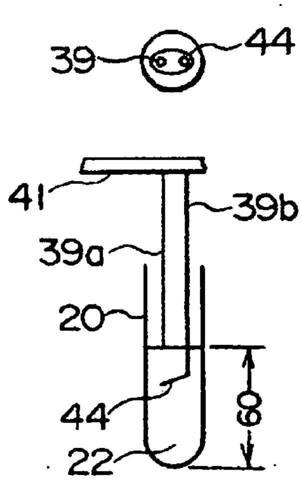


FIG. 4B

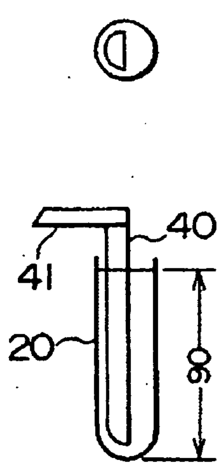


FIG. 4C

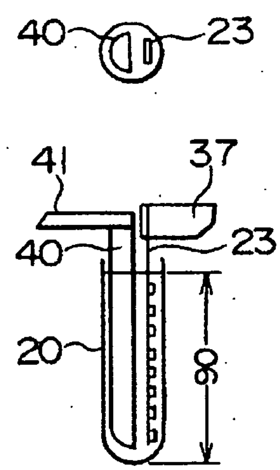


FIG. 5

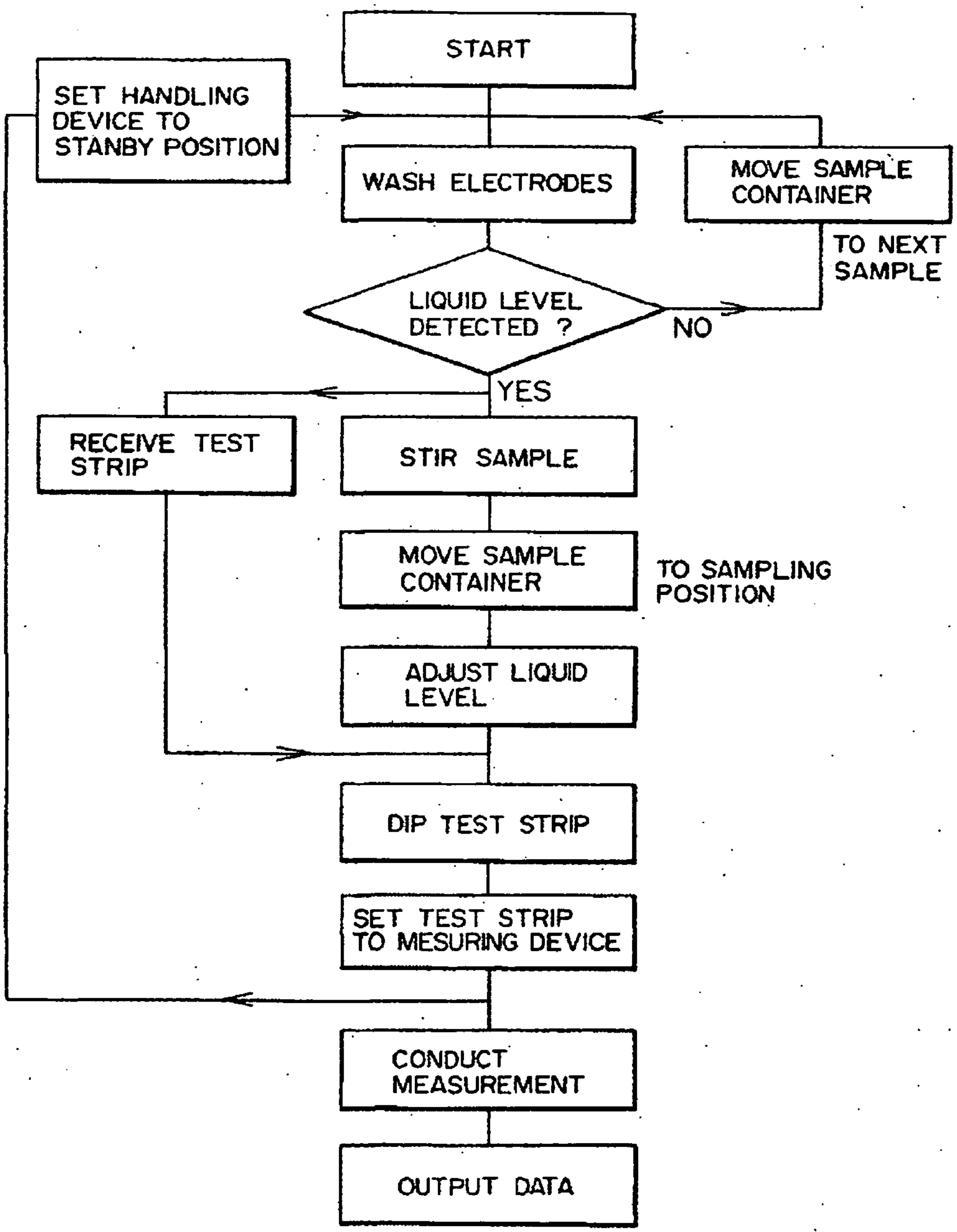

START
SET HANDLING DEVICE TO STANBY POSITION
WASH ELECTRODES
MOVE SAMPLE CONTAINER
TO NEXT SAMPLE
LIQUID LEVEL DETECTED ?
NO
YES
RECEIVE TEST STRIP
STIR SAMPLE
MOVE SAMPLE CONTAINER
TO SAMPLING POSITION
ADJUST LIQUID LEVEL
DIP TEST STRIP
SET TEST STRIP TO MESURING DEVICE
CONDUCT MEASUREMENT
OUTPUT DATA

FIG. 6

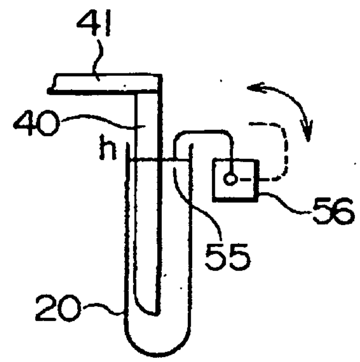
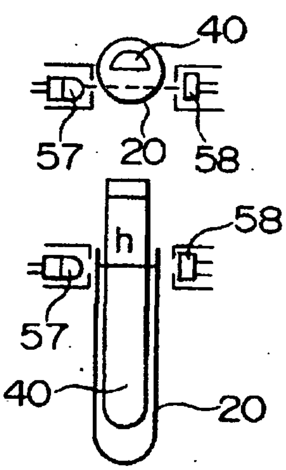


FIG. 7



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 92 11 8011

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
A	DE-A-3 241 922 (WALTER SARSTEDT KUNSTOFF-SPRITZGUSSWERK) * page 4, paragraph 2 - page 5, paragraph 2; figures 1-4 *	1,2,4	G01N35/00
A	EP-A-0 180 792 (KABUSHIKI KAISHA KYOTO DAIICHI KAGAKU) * abstract * * page 6, line 20 - page 8, line 2; figure 1 *	1,4,7,8, 10,12,13	
D	& US-A-4 876 204 (KAZUSHIGE INOUE)		
A	US-A-4 578 588 (GALKIN) * column 2, line 26 - line 46; claim 1; figures 1-6 *	1,2,4, 6-9	
D,A	US-A-4 451 433 (HITACHI) * abstract; claim 2; figures 1,4 *	1,3-5,7, 8,13-15	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)
G01N
B01L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	29 JANUARY 1993	MILLS J.

CATEGORY OF CITED DOCUMENTS

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